

# **WIRELESS COMMUNICATION APPARATUS, WIRELESS COMMUNICATION METHOD THEREOF, AND WIRELESS COMMUNICATION SYSTEM EMPLOYING THE SAME**

## **BACKGROUND OF THE INVENTION**

### **1. Field of the Invention**

[001] The present invention relates to wireless communication, and more particularly to a wireless communication apparatus, a wireless communication method thereof, and a wireless communication system employing the same, for enabling peer-to-peer communication between slave devices through master-to-slave switching.

### **2. Description of the Related Art**

[002] FIG. 1 is a view showing the structure of a Piconet in a general Bluetooth communication system.

[003] In a current Bluetooth system, one unit U10 operating as a master device, and a plurality of units U20, U30, and U40 operating as slave devices form a Piconet, as shown in FIG. 1. At most, seven slave devices can participate in one Piconet for one master device U10.

[004] In the Piconet, channels are established between the master device U10 and the slave devices U20, U30 and U40, and data is transmitted in the form of a packet. FIG. 2(a) shows the general form of the transmitted packet, and FIG. 2(b) shows the header part of the packet of FIG. 2(a) in greater detail.

- [005] Master device U10 allocates an active member address (AM\_ADDR) to the slave devices U20-U40 of the Piconet. The active member address AM\_ADDR of the slave devices U20, U30 and U40 is written in the header part of the packet and transmitted.
- [006] In accordance with the current Bluetooth communications, a master-driven Time Division Duplex method is used. If the master device appoints a certain slave device and transmits data to the appointed slave device, then the slave device that received the data transmits the response data to the master device.
- [007] Accordingly, slave devices only transmit data to the master device, and are unable to transmit data to other slave devices of the Piconet.
- [008] If master-to-slave switching is performed between one slave device and the master device of the Piconet, the slave device becomes a new master device and can communicate with other slave devices.
- [009] In the current Bluetooth communication system, by employing master-to-slave switching, the information of the original master device is transmitted to a new master device, and the other slave devices of the Piconet communicate according to the clock of the new master device. This is done by changing transmitter and receiver timing according to the clock of the new master device.
- [010] Next, the master-to-slave switching in the current Bluetooth system will be described in greater detail with reference to the accompanying drawings.
- [011] FIG. 3 is a diagram illustrating a signal flow during the conventional master-to-slave switching in the Piconet of FIG. 1.

[012] First, the first unit U10, i.e., the old master device, requests master-to-slave switching to the second unit U20, i.e., one of the slave devices of the Piconet, according to a hopping sequence thereof (step S302). If the second unit U20 agrees to be a new master device, the second unit U20 sends a response signal to the old master device U10 (step S304).

[013] Hereinafter, the first unit U10 is defined as an old master device, and the second unit U20 as a new master device.

[014] The new master device U20 sends the old master device U10 an indication of a difference in the starts of master-to-slave slots between the new master device U20 and the old master device U10 through a time alignment Link Manager Protocol (LMP) message (step S306). The LMP message allows the old master device U10 to become synchronized with the clock of the new master device U20.

[015] Further, the new master device U20 sends a Frequency Hopping Sequence (FHS) packet containing a new active member address AM\_ADDR to the old master device U10 (step S308). Then the old master device U10 sends a FHS packet response to the new master device U20 (step S310). Accordingly, the new master device U20 exchanges the data transmission timing, namely transmitter and receiver timing, with the old master device U10.

[016] The new master device U20 also sends the other slave devices, i.e., the third unit U30 and the fourth unit U40, the same time alignment LMP message and FHS packet that are sent to the old master device U10.

[017] More specifically, the new master device U20 transmits the time alignment LMP message and the FHS packet to the third unit U30 (steps S312, S314). Then the new master device U20 receives a FHS response packet from the third unit U30 (step S316).

[018] Further, the new master device U20 transmits the time alignment LMP message and the FHS packet to the fourth unit U40 (steps S318, S320). Then, the new master device U20 receives the FHS response packet from the fourth unit U40 (step S322).

[019] Through the switching processes S312-S322 in the Piconet, the slave devices such as the third and the fourth units U30 and U40 can send and receive data in accordance with the clock of the new master device U20, and receive the active member address AM\_ADDR from the new master device U20.

[020] After receipt of the FHS response, the new master device U20 switches timing, and sends a poll packet to the third and the fourth units U30 and U40 to confirm whether the respective slave devices are switched to the timing of the new master device U20 (steps S324, S326).

[021] FIG. 4 is a view showing the structure of the Piconet of FIG. 1, after the conventional master-to-slave switching.

[022] As shown in FIG. 4, the second unit U20 has taken the function of the master device, while other units U10, U30, and U40 operate as slave devices in the Piconet.

[023] Since the second unit U20, which was a slave device in the Piconet of FIG. 1, has become a master device of the Piconet of FIG. 4, the second unit U20

now can communicate with the other slave devices U10, U30 and U40 (see FIG 4).

[024] According to the above-described master-to-slave switching method of the current Bluetooth communication system, since the slave devices of the Piconet have to be allocated with new active member addresses (AM\_ADDR) from a new master device, and change transmitter and receiving timing according to the clock information of the new master device, the procedure is very complex and requires a considerable amount of processing time.

[025] Accordingly, there has been an increasing demand for a new communication method that would enable peer-to-peer communication between the slave devices through more rapid master-to-slave switching.

#### SUMMARY OF THE INVENTION

[026] The present invention has been made to overcome the above-mentioned problems of the related art, and accordingly, it is an object of the present invention to provide a wireless communication apparatus, a wireless communication method, and a wireless communication system employing the same, which enable peer-to-peer communication between slave devices in a manner such that a slave device of a general Piconet uses a Frequency Hopping Sequence of a master device of the Piconet as it is.

[027] The above object is accomplished by providing a wireless communication apparatus connected with one or more slave devices in a network. The wireless communication apparatus retains information about the connected slave devices in accordance with the present invention. The apparatus includes a transceiving

portion for receiving externally transmitted data, and transmitting a signal, and a controller for requesting through the transceiving portion a certain slave device of the connected slave devices to perform a function of a master device for a predetermined time, and transmitting Piconet information about the connected slave devices of the network.

[028] Preferably, the controller exchanges data transmission timing with the certain slave device that is requested to perform the function of the master device.

[029] The above object is also accomplished by a wireless communication apparatus connected with a master device in a network in accordance with the present invention, including a transceiving portion for receiving externally transmitted data, and transmitting a signal, and a controller for receiving a request from the master device that requests a certain slave device to perform a function of a master device for a predetermined time. The controller receives Piconet information about other slave devices in the network from the master device, and is used to communicate with the other slave devices in the network for a predetermined time as a temporary master device.

[030] Preferably, the controller exchanges data transmission timing with the master device.

[031] The above object is also accomplished by a wireless communication method of a wireless communication apparatus which is connected with one or more slave devices in a network, and includes information about the connected slave devices in accordance with the present invention. The method includes requesting a certain slave device of the connected slave devices to perform a

function of a master device for a predetermined time, and sending Piconet information about other slave devices of the connected slave devices of the network to the certain slave device.

[032] The above object is also accomplished by a wireless communication method of a wireless communication apparatus connected with a master device in a network in accordance with the present invention. The method including; (a) a previous slave device being requested by the master device to perform a function of a temporary master device for a predetermined time, (b) receiving Piconet information about slave devices connected in the network from the master device, and (c) communicating with the other slave devices of the network as the temporary master device for the predetermined time.

[033] Preferably, the process of receiving Piconet information, mentioned above, includes exchanging data transmission timing with the master device, and the process of communicating with other slave devices includes updating, as the temporary master device, the Piconet information about the connected slave devices of the network, and sending the updated information to the master device after a predetermined time.

[034] The objects of the present invention are also accomplished by a wireless communication system, including one or more slave devices connected to the wireless communication system, and a master device having information about the connected slave devices. The master device requests a certain slave device of the connected slave devices to perform a function of a temporary master device for a predetermined time, exchanges data transmission timing with the certain slave device, and sends Piconet information about other slave devices of the

connected slave device. The slave device receives the Piconet information about the other slave devices from the master device, and communicates as the temporary master device with the other slave devices for the predetermined time.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

[035] The above object and other features of the present invention will be clarified by the following description with the attached drawings, in which:

[036] FIG. 1 is a view showing the structure of a Piconet of current Bluetooth communication system;

[037] FIG. 2 is a view showing a packet transmitted in the Piconet, in which FIG. 2(a) shows the general form of the packet, and FIG. 2(b) shows a header of the packet in greater detail;

[038] FIG. 3 is a diagram showing a flow of signal during the conventional master-to-slave switching in the Piconet of FIG. 1;

[039] FIG. 4 is a view showing the structure of the Piconet after the conventional master-to-slave switching shown in FIG. 3;

[040] FIG. 5 is a block diagram showing a wireless communication apparatus according to the present invention;

[041] FIG. 6 is a view showing signal flow when a rapid master-to-slave switching is performed in the Piconet of FIG. 5 according to a preferred embodiment of the present invention; and

[042] FIG. 7 is a view showing the structure of the Piconet after the rapid master-to-slave switching shown in FIG. 6.



## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[043] Hereinafter, a wireless communication apparatus, a wireless communication method thereof, and a wireless communication system employing the same according to a preferred embodiment of the present invention will be described in greater detail with reference to the appended drawings.

[044] FIG. 5 is a block diagram showing the wireless communication apparatus according to the present invention.

[045] As shown in FIG. 5, the wireless communication apparatus 20(30) includes a transceiving portion 21(31), and a controller 23(33), wherein the reference numerals 20, 21, 23, and 40 refer to the wireless communication apparatus operating as a slave and its elements, while the reference numerals in parenthesis, i.e., 30, 31, 33 and 50 refer to the wireless communication apparatus operating as a master device and its elements.

[046] First, the wireless communication apparatus 20 operating as a slave will be described below.

[047] The transceiving portion 21 processes a signal received from the outside, such as a radio frequency (RF) signal, and sends out a transmission-intended packet.

[048] The controller 23 is connected to a host 40 via a communication interface. The host can be various communication terminals, such as a laptop computer, mobile phone, and printer, or the like.

[049] The controller processes the signal requested by the host 40, and also processes the signal received through the transceiving portion 21.

[050] The wireless communication apparatus 20 operates as a slave device in a wireless network in which the wireless communication apparatus 20 is connected with other wireless communication apparatuses. Upon receipt of request from the master device through the transceiving portion 21 to operate as a master device for a predetermined time, the controller 23 of the wireless communication apparatus 20, operating as a slave device, exchanges data transmission timing with the wireless communication apparatus operating as a master device.

[051] Further, the controller 23 of the wireless communication apparatus 20 receives Piconet information about the slave devices connected in the network, thereby enabling communication with other slave devices as a temporary master device for a predetermined time.

[052] Next, the wireless communication apparatus 30 operating as a master device will be described.

[053] The wireless communication apparatus 30 operating as a master device requests one of the slaves of the network to operate as a new master device for a predetermined time.

[054] Accordingly, the controller 33 exchanges data transmission timing with the requested slave device, and sends the Piconet information including the active member addresses AM\_ADDR of the slave devices connected in the network.

[055] The master-to-slave switching between the wireless communication apparatuses 20 and 30 respectively operating as a slave device and a master device for performing a peer-to-peer communication, will be described below with reference to FIG. 6.

- [056] Referring to FIG. 6, the original master device of the Piconet is defined as an anchored master device, while the unit temporarily operating as the master is defined as a dynamic master device.
- [057] The first unit U1 that is an anchored master requests a master-to-slave switching to the second unit U2 to be a dynamic master device intending to transfer its master function to the second unit U2 (step S602).
- [058] If the second unit U2 responds by agreeing with the master-slave-switching (step S604), receiver and transmitter timing exchange (i.e., TDD) is carried out between the anchored master device U1 and the second unit U2.
- [059] The anchored master device U1 transmits basic Piconet information such as the active member addresses AM\_ADDR of the slave devices connected in the Piconet (step S606).
- [060] The second unit U2 performs the function of the master device for a predetermined time, communicating with other slave devices and updating the Piconet information of the slave devices (step S608). After the predetermined time, the second unit U2 transmits the updated Piconet information to the anchored master device (step S614).
- [061] As described above, the dynamic master device receives the function of the master device from the anchored master device. The dynamic master operates as the master device for a predetermined time, using the frequency hopping sequence and the clock of the anchored master device without alteration, which are based on the Bluetooth device address BD\_ADDR of the anchored master device.

[062] Accordingly, unlike conventional master-to-slave switching, there is no need to transmit the FHS packet containing Bluetooth device address (BD\_ADDR) of the new master device to the slaves.

[063] FIG. 7 is a view showing the structure of the Piconet after the master-to-slave switching shown in FIG. 6.

[064] The second unit U2, which becomes the dynamic master device, does not communicate via the first unit U1, which is the anchored unit (FIG. 7), but communicates directly with the third unit U3. Accordingly, the peer-to-peer communication between the second and the third units U2 and U3 becomes possible.

[065] As described above, in the wireless communication apparatus, the wireless communication method thereof, and the wireless communication system employing the same according to the present invention, since the slave communicates with other slaves as the dynamic master device while using the frequency hopping sequence of the old master device, i.e., the anchored master device without change, the dynamic master device does not have to transmit its frequency hopping sequence and the clock to the slaves, and thus, much time can be saved.

[066] Further, since the dynamic master device does not have to allocate new active member addresses AM\_ADDR to the slaves, the master-to-slave switching can be carried out rapidly.

[067] The present invention is not restricted to the foregoing embodiment thereof and changes can be made by those skilled in the art without departing

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
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